(12) UK Patent Application (19) GB (11) 2 067 670 A

(21) Application No 8100954
(22) Date of filing 13 Jan 1981
(30) Priority data
(31) 8001368
(32) 15 Jan 1980
(33) United Kingdom (GB)
(43) Application published 30 Jul 1981
(51) INT CL³ F03D 7/06
(52) Domestic classification F1T W1B1 F1V 112 DA
(56) Documents cited GB 1486338 US 4125343A
(58) Field of search F1T F1V

(71) Applicant
Roland Store,
Broomhill, 67 Seven Mile Straight, Antrim, Co. Antrim, BT 41 4TQ, Northern Ireland
(72) Inventor
Roland Store

(54) Wind Rotor

(57) A wind rotor mounted on a vertical shaft 18 has vanes 14, 16 rotatably mounted between end discs 20, 31 and connected via bevel gearing 26, 27, 28 and a gearbox 29 to a central bevel gear 25 much that each vane rotates about its own axis as the rotor rotates. Bevel gear 25 is normally stationary but can be adjusted by worm 24 in response to changes in wind direction so as to alter orientation of the vanes. The latter can be feathered by changing the ratio of gearbox 29 from 2:1 to 1:1 when a centrifugal plate 33 moves outwardly into contact with the gearbox selector lever.

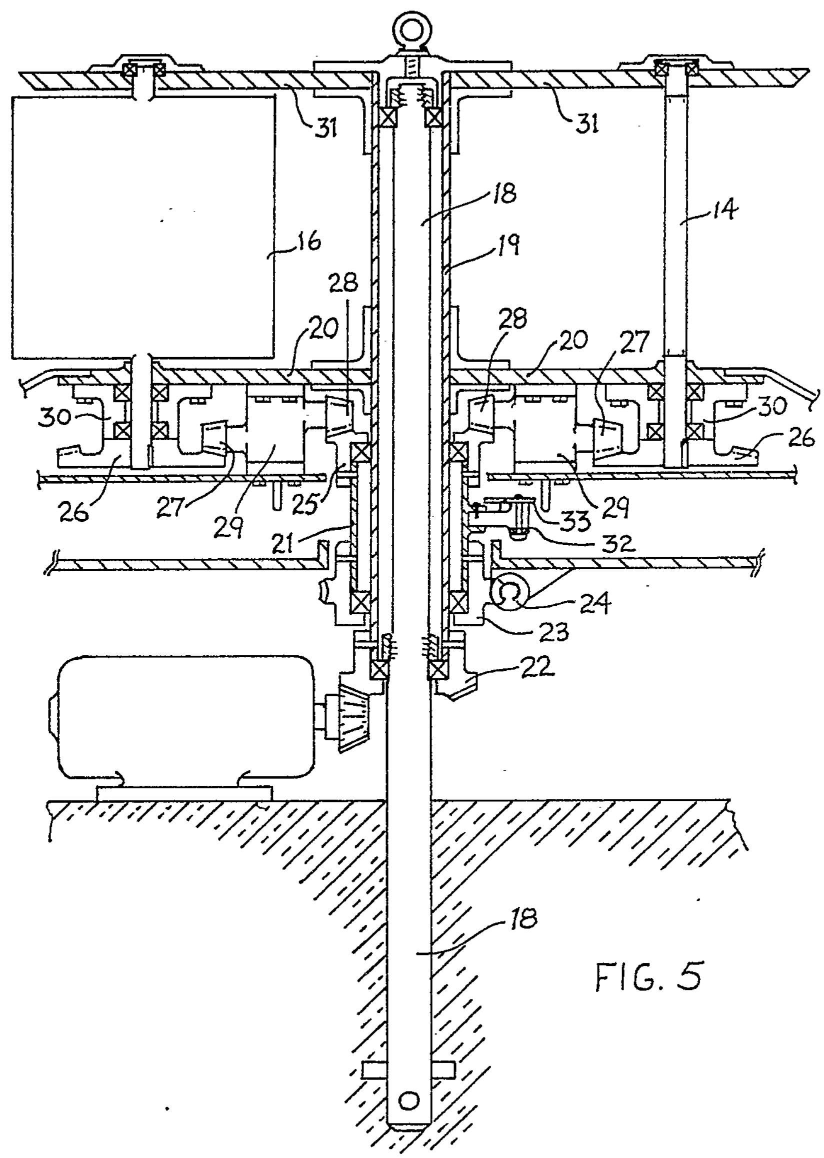


FIG. 5

GB 2 067 670 A

2067670

1/4

FIG. 1

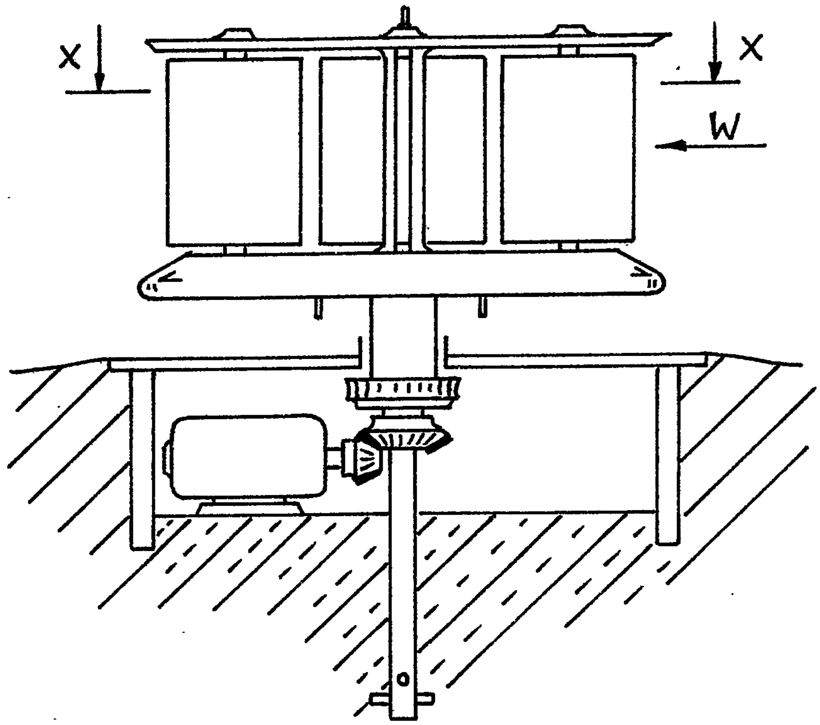


FIG. 2

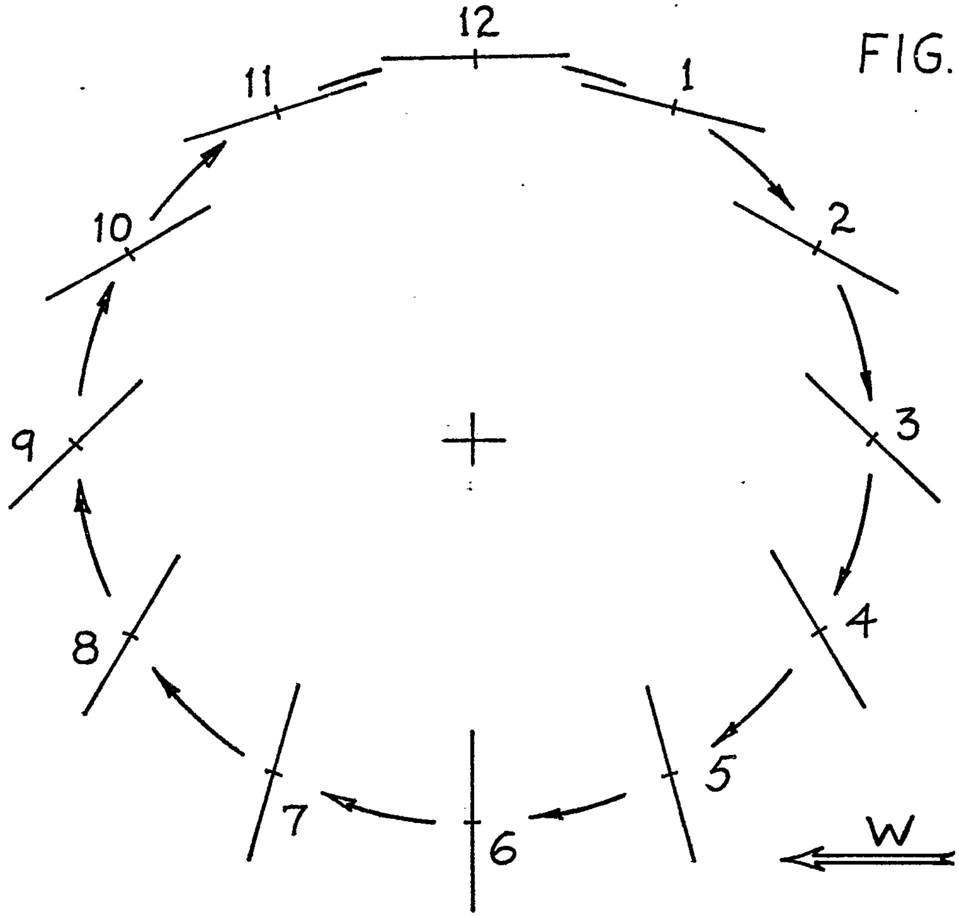


FIG. 3

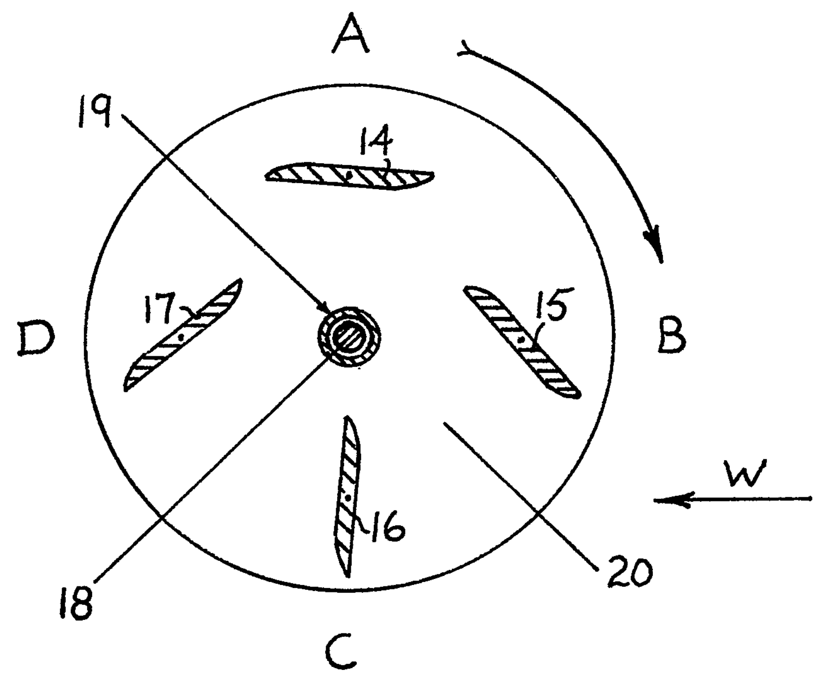
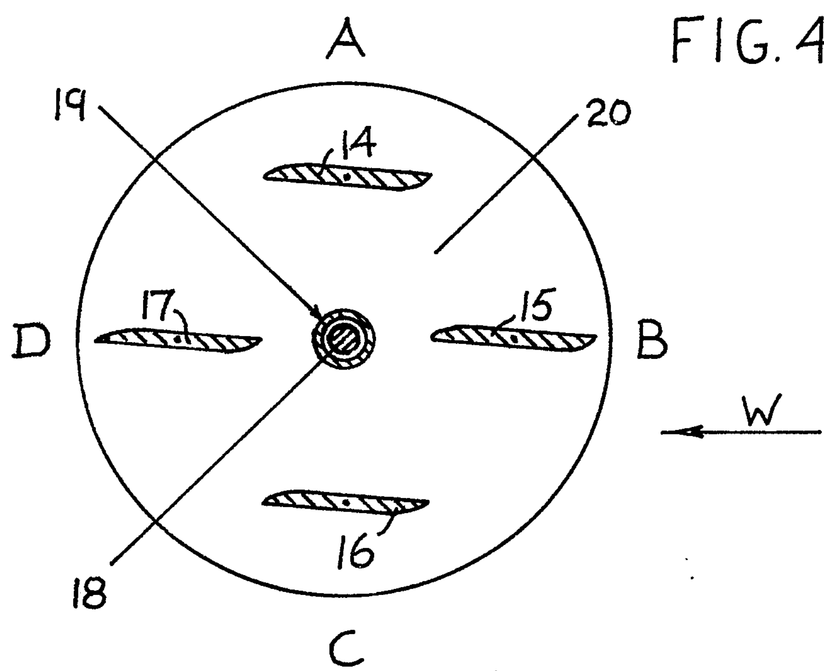


FIG. 4



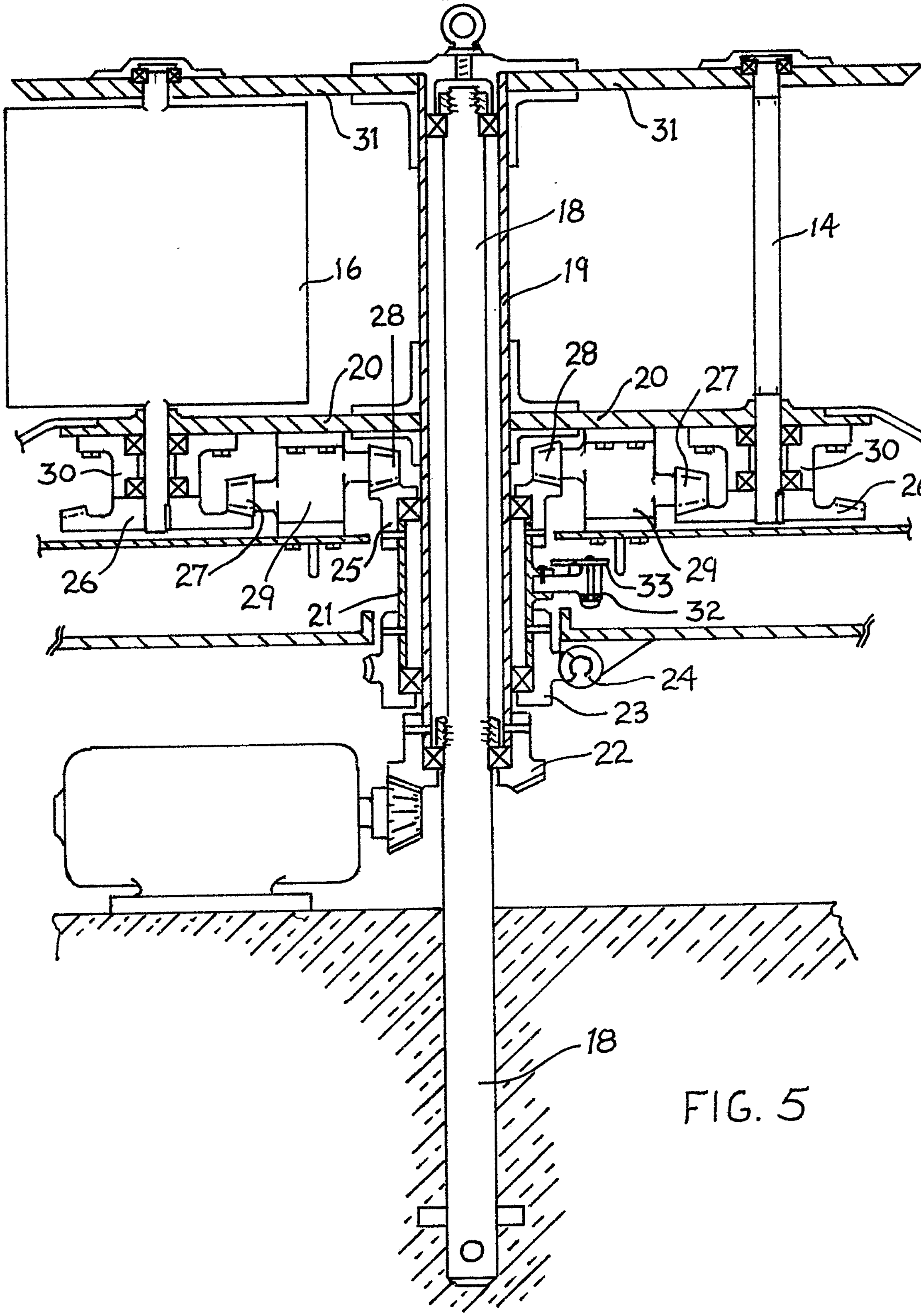
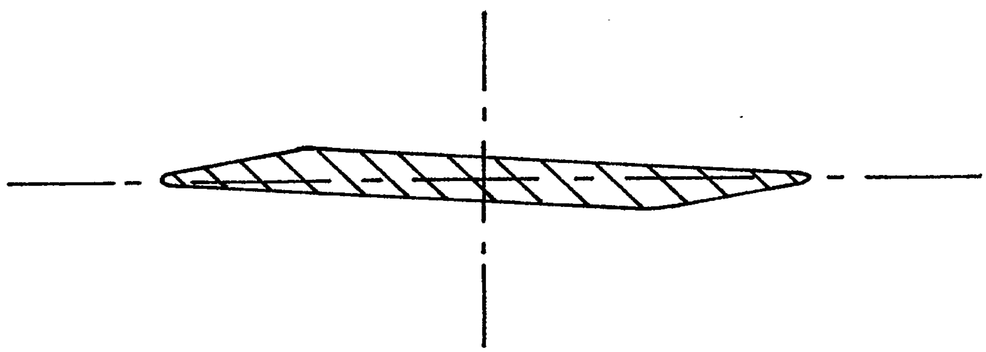

31
31
18
14
16
19
28
28
20
20
27
30
30
26
26
27
29
25
29
33
32
21
24
23
22
18

FIG. 5

2067670

FIG. 6



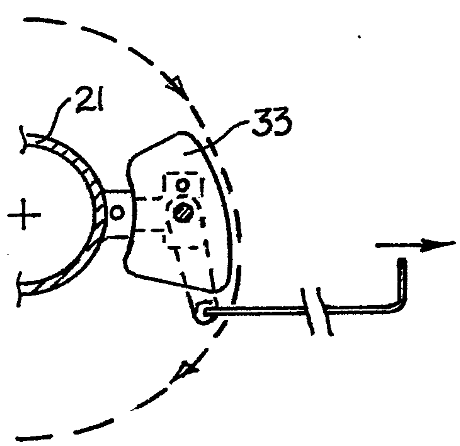


FIG. 7

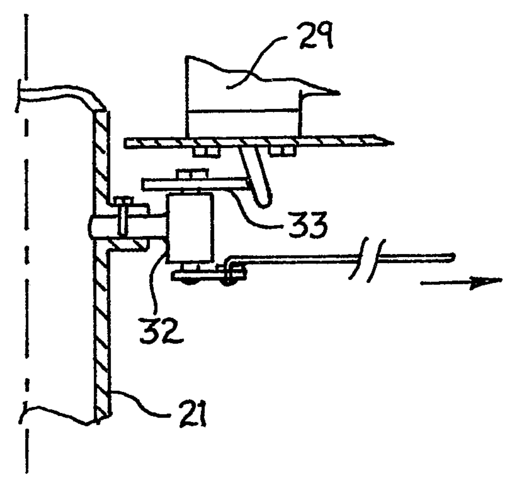


FIG. 8

SPECIFICATION
Wind Rotor

This invention relates to a wind rotor, which may be used to harness the energy inherent in the wind.

British Patent No. 1,486,338 entitled Wind or Water Powered Machines describes a machine of which the present invention is a development. As stated in Patent No. 1,486,338, "a wind or water powered machine comprises a rotatable shaft having a plurality of drive vanes which are rotatably mounted on supports extending radially outwardly from the shaft so that the drive vanes can rotate about equispaced axes parallel with the shaft, a rudder vane mounted on a support rotatably mounted on the shaft, or a remote shaft, and a drive connection between each drive vane and the rudder vane support to provide a gear ratio of 1:2 between the drive vanes and the rudder support."

The wind rotor disclosed herein differs substantially from the preferred embodiment of the machine described in the quoted patent, both with respect to the manner of construction and in particular with respect to the drive connection which herein incorporates an original system for protecting the rotor from excessively strong winds. A further innovation concerns the cross-sectional shape of the individual wind vanes.

An embodiment of the invention will hereinafter be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a side view of the wind rotor.

Figure 2 is a diagrammatic representation, seen in plan, showing successive positions of the rotating wind vanes.

Figure 3 is a cross-sectional view seen from the line X—X in Figure 1 showing the relative positions of four wind vanes with respect to the wind direction shown by the arrow W.

Figure 4 is a cross-sectional view seen from the line X—X in Figure 1 showing the four wind vanes in a "feathered" position.

Figure 5 is a mid-sectional side view of the wind rotor showing wind vanes 14 and 16 as seen in the direction of the arrow W. This view is shown at an enlarged scale.

Figure 6 is an enlarged transverse cross-sectional view of an individual wind vane.

Figure 7 is a detail plan view of profiled plate 33 and associated components.

Figure 8 is a detail side view of profiled plate 33 and associated components.

Figure 1 represents a general arrangement of the wind rotor with a generator housing below ground level. The rotation of the wind rotor is conveyed to a generator or other driven apparatus by means of bevel gearing and if desired more than one generator or other apparatus may be driven in this way. Although the arrangement illustrated in Figure 1 shows the foundations of the rotor below ground level, it would also be possible to elevate the whole rotor by mounting the structure on a concrete pedestal set above ground level. Preferably such a pedestal would have provision for housing the driven apparatus and associated equipment.

Figure 3 shows how four wind vanes would be orientated with respect to the prevailing wind direction indicated by arrow W. It is further shown diagrammatically in Figure 2 how the successive orientation of each vane alters in conjunction with the overall rotation of the rotor as a whole. A system of bevel gears has been devised for controlling the orientation of the wind vanes.

With reference to Figure 5, component 18 is a rigidly mounted vertical upright about which the rotor as a whole is rotatable. Preferably the lower end of component 18 should be set rigidly in concrete. Tubular column 19 forms the main shaft of the rotor and is rotatably mounted on bearings concentric with component 18. A circular turntable 20 is concentrically secured with its plane at right angles to the central column and carries wind vanes 14, 15, 16 and 17 with the central axis of each wind vane rotatably located at equal radial distances from the rotor axis and at 90° intervals around the turntable. The upper end of each wind vane shaft is located in a bearing situated in an upper turntable 31 mounted in a similar manner to the lower turntable.

The drive mechanism for the vanes is mounted on the underside of turntable 20 being enclosed below and at the outer edge of the turntable by suitably shaped fairings.

The wind rotor described herein does not utilise a full size rudder vane but substitutes an auxiliary control system coupled to a wind alignment mechanism. The control system utilises information on wind direction supplied by a small remote wind direction indicator. The information on wind direction is used to control the motive power of a servo motor which is connected to drive a worm gear 24 shown in Figure 5. Worm gear 24 mates with worm wheel 23 which is fixed on to sleeve 21, which is concentrically mounted on bearings and is freely rotatable about component 19. At the underside of the lower turntable a ring bevel gear 25 is fixed to the upper end of component 21. Sleeve 21 and attached components are normally in a stationary position even when the rotor is in motion; however operation of worm and wheel drive 23 and 24 alters the orientation of bevel gear 25 and this has the effect of altering the orientation of the wind vanes so that they are suitably orientated to respond to the prevailing wind direction.

It is felt that the aforementioned method of aligning the rotor with the wind would be more positive and versatile than the use of a rudder vane, particularly where large scale wind rotors are concerned.

As the wind acts on the wind vanes, the rotor as a whole begins to turn and through the action of the drive linkage it is possible for each wind vane to be progressively orientated. The drive linkages to wind vanes 14, 15, 16 and 17 are all identical and Figure 5 shows two such linkages to

wind vanes 14 and 16 repectively. Ring bevel gear 25 forms the hub of the drive linkages to the individual wind vanes and if the wind is steady and the wind alignment mechanism is correctly set, then bevel gear 25 will be in a steady stationary position with respect to the moving rotor. Considering the drive linkage to wind vane 16, we find that as turntable 20 is carried round by the action of the wind on vane 16, the small bevel gear 28 is turned by the stationary gear 25. The rotation of gear 28 is conveyed through gear box 29 and bevel gear 27 to drive gear 26 which is connected to the central shaft of wind vane 16. The lower extremity of each wind vane shaft is rotatably mounted in component 30 which contains two bearings to ensure adequate support.

As stated in Patent No. 1,486,338 it is necessary for the overall drive ratio to the wind vanes to be 2:1, so that each vane turns at half the speed of the overall rotational speed of the wind rotor. The drive linkage will progressively orientate each vane in an anticlockwise direction of the main rotation of the rotor is in a clockwise direction.

Considering the rotation of gear 28 on the input side of gear box 29, there is a 2:1 reduction in the gear box so that gear 27 on the output side will rotate at half the rate of rotation of gear 28. By incorporating reduction gearing in this way it is possible to keep the dimensions of drive gear 26 within reasonable proportions; in fact 26 becomes an identical gear to 25 and similarly 27 and 28 are identical gears.

There is an additional feature which may be incorporated in gear box 29, namely a 1:1 drive ratio along side the 2:1 reduction gearing. A 1:1 drive connection to the wind vanes can be used to good effect in order to keep all the wind vanes edge on into the wind in a "feathered" position. By "feathering" the wind vanes by the proposed method, the wind rotor may be effectively protected from damage by excessively strong winds. Figure 4 shows the four wind vanes in a feathered position relative to the wind direction indicated by the arrow W. The feathered condition can be achieved by selecting a 1:1 drive ratio at the appropriate gear box as each respective vane passes the upwind position indicated by vane 14 in Figure 3.

The gear box with a selectable drive ratio of 2:1 or 1:1 would preferably employ constant meshing gears with provision for spontaneous selection of either ratio whilst the gear box is still transmitting torque. It should be noted that with a pair of constant meshing gears the teeth of the two gears are permanently in contact and one of the gears is allowed to freewheel on the respective shaft. In order for the said pair of gears to transmit torque, the freewheeling gear is spontaneously locked onto the respective shaft by a frictional device or other means. At the same time a neighbouring pair of constant meshing gears could be released from transmitting torque by allowing one of the gears to freewheel on the respective shaft. Spontaneous interchange of gear ratios would be brought about in the aforementioned manner by the movement of a selector lever made integrally with the gear box.

Although full details of auxiliary mechanisms are beyond the scope of this specification it can be said that a centrifugally actuated mechanism is envisaged for initiating feathering of the wind vanes. The mechanism would be activated when the rotational speed of the wind rotor becomes too high and would bring about a permanent deflection of profiled plate 33. Component 33 is mounted on a stationary side arm 32 situated on a radial line perpendicular to the wind direction on the upwind side of the rotor and the centrifugal mechanism could readily be housed in the enclosed space of the lower turntable. It would be a matter of releasing a spring loaded component from under the rotating turntable so that the said component would impinge on the inner edge of profile plate 33 and a permanent deflection of the said plate would result. The shape of plate 33 would be such that in the deflected position the outer edge of the plate would impinge on the protruding gear box selector levers as the respective wind vanes passed through the upwind position. By thus altering the drive ratio of the gear boxes the wind vanes would become feathered. When all the wind vanes have thus been feathered they will maintain an edge on position into the wind regardless of whether the rotor as a whole continues to rotate or not. Under the aforementioned conditions the wind alignment mechanism will still be functional and will ensure that the wind vanes remain orientated edge on into the wind even if the wind direction changes.

The proposed wind alignment mechanism and control system offer one additional possibility. It may be desirable to turn the rotor out of alignment with the wind in order to curtail the speed of rotation. This would be possible with the proposed system but could not readily be achieved if a rudder vane were used. Using the wind alignment mechanism it would be possible to turn the rotor a full 90° out of alignment with the wind, resulting in a complete neutralisation of the rotational power. It follows that progressive misalignment with the wind direction up to a maximum of 90° would progressively reduce the speed of rotation.

It should be pointed out however that operating the rotor out of alignment with the wind may result in considerable wind loads on the vanes however, considered as an additional measure, the aforementioned feathering technique would offer a fuller measure of protection.

Nevertheless as an interim measure it may be desirable to hold off the feathering of the wind vanes by running the rotor out of alignment with the wind, thus keeping the rotational speed at an acceptable level whilst continuing to generate power. The aforesaid condition could be achieved by feeding not only information on wind direction into the alignment control system but also

information on wind speed. Beyond a certain wind speed it would thus be possible to progressively displace the alignment up to a predermined limit and if the rotational speed was still too high the wind vanes would be automatically realigned and spontaneously feathered After feathering and when the wind has subsided it would be necessary to reset the drive linkages prior to recommencing power generation.

It can be seen from figures 3 and 4 that a special cross-sectional shape has been used for the wind vanes. The shape is illustrated more clearly in the enlarged view in Figure 6 which represents a typical transverse cross section of the wind vanes. The cross-sectional shape is based on a parallelogram with the mid plane of the wind vane corresponding to the longest diagonal of the parallelogram. The surfaces of the wind vane are so placed that the wind forces induced assist rotation about the central axis of the vane in the required direction.

In the foregoing text coverage has been given to proposed auxilary systems both with respect to the operation of the wind alignment mechanism and also with respect to the system for initiating feathering of the wind vanes. However it should be said that in the simplest case the functions of both wind alignment and feathering may be carried out manually.

For manual operation of the wind alignment mechanism it is necessary to turn the worm gear 24 by means of a cranked handle until the correct alignment has been reached.

Manual feathering of the wind vanes can be carried out from a point beyond the outside edge of the lower turntable by pulling a horizontal tie rod which is attached to a lever connected to profiled plate 33 as shown in Figures 7 and 8. Pulling the tie rod permanently alters the position of plate 33, which is retained in the deflected position by a spring loaded catch adjacent to the pivot of component 33 on side arm 32. When plate 33 has attained the deflected position the selector levers of the respective gear boxes moving in the path indicated by the dotted line in Figure 7, will be activated by impinging on the outer edge of the profiled plate, thus initiating feathering of the wind vanes.

In the undermentioned claims it is necessary to refer to the arrangement and location of a plurality of rotatable, radially spaced wind vanes in relation to a central column or shaft and it is further necessary to refer to drive connections operating at a gear ratio of 2:1 which govern the orientation of the respective wind vanes. The two aforementioned features are previously covered in claim 1 of British Patent 1,486,338.

Claims

1. A wind rotor comprising a central ring bevel gear of controllable orientation concentrically secured to a sleeve which is coaxially mounted on a central column, with a smaller mating bevel gear moving around the circumference of the ring bevel gear and the resulting rotation of the shaft of the small mating gear being conveyed through an intermediary gear box having parallel shafts and a drive ratio of 2:1 to an identical small bevel gear on the output shaft of the gear box; a small bevel gear on the output shaft of the gear box which mates with a wind vane drive gear which has the same number of teeth as the central ring gear; the gears being so arranged that the wind vane drive gear and central ring gear lie in parallel planes with the direction of rotation of the wind vane drive gear contrary to the overall direction of rotation of the wind rotor.

Claim 1 is characterised by the use of bevel gears for the drive linkage connecting the central ring gear to the wind vanes and is further characterised by the inclusion of an intermediary gear box in each drive linkage.

2. A wind rotor according to claim 1 wherein a fixed vertical upright has a lower extremity set rigidly in a concrete base and an upper extremity about which a central tubular column is coaxially mounted on bearings with the lower extremity of the central column connected to a concentrically mounted bevel gear which drives one or more electrical generators or other apparatus through mating bevel gears.

3. A wind rotor according to claims 1 or 2 which comprises upper and lower circular turntables concentrically fixed to a central tubular column, with the respective plane of each turntable at right angles to the central column; upper and lower turntables which respectively secure the upper and lower extremities of the central vertical shaft of each of a plurality of wind vanes, which are rotatably mounted about the said vertical shafts, which are equidistant, equally spaced and parallel in relation to the central column.

Claim 3 is characterised by the inclusion of upper and lower turntables rigidly fixed to a central column.

4. A wind rotor according to claim 1 comprising a plurality of wind vane drive linkages, which incorporate in each linkage an intermediary gear box having, in addition to a 2:1 drive ratio, a spontaneously selectable drive ratio of 1:1.

5. A wind rotor according to claim 1, 3 or 4 incorporating a wind alignment mechanism which comprises a rotatable sleeve coaxially mounted on a central column with the upper extremity of the sleeve connected to a ring bevel gear from which the wind vane drive linkages radiate; a ring bevel gear which may be rotatably orientated by worm and wheel gearing connected to the lower extremity of the sleeve, such that the externally anchored worm gear may be turned manually or mechanically; a mechanically acitvated worm gear rotated by a powered servo-motor whose motion is governed in accordance with variations in wind direction and wind speed, in order to control the overall orientation of the wind alignment mechanism, which governs the orientation of the individual wind vanes with respect to the wind direction.

6. A wind rotor according to claim 4 or 5 incorporating a wind alignment mechanism part of which comprises a coaxial sleeve which carries a side arm projecting along a radial line perpendicular to the wind direction on the upwind side of the rotor; a radial side arm on which is pivoted a horizontal profiled plate which may be moved in a horizontal direction so that projecting gear selector levers will impinge on the edge of the plate and be progressively activated causing a spontaneous gear change in each successive drive linkage in order to initiate feathering of the wind vanes.

7. A wind rotor according to any of claims 1—6 comprising a plurality of wind vanes with each wind vane having a transverse cross-sectional shape with the outline of the said shape conforming to the geometrical figure known as a parallelogram with the added feature that all sharp corners are narrowly rounded; a plurality of wind vanes incorporated in the wind rotor in such a manner that the wind striking the short side of the transverse cross-sectional shape induces rotation of the wind vane about a central longitudinal axis in the required rotational direction.

8. A wind rotor substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.